

WHAT IS CLAIMED IS:

1. A method of delivering a molecule to the skeletal muscle of a mammal in vivo, comprising:

(a) injecting a molecule into skeletal muscle of a mammal, whereby a penetration site and a treatment region are created;

(b) positioning electrodes spaced from said penetration site such that current traveling between the electrodes passes through the treatment region; and

(c) electrically stimulating the muscle with an electrical current.

2. The method of claim 1, wherein said current generates a field strength in the range of from about 25 V/cm to less than 250 V/cm.

3. The method of claim 1, wherein said electrical stimulation is delivered in the form of a single pulse.

4. The method of claim 3, wherein said pulse has a duration of between about 50 μ s and 5000 μ s.

5. The method of claim 1, wherein said electrical stimulation is delivered in the form of between about 2 to 30,000 pulses.

6. The method claim 5, wherein said pulses have a total duration of between about 10 ms to 12,000 ms.

7. The method of claim 6, wherein said pulses are delivered in the form of at least two trains.

8. The method of claim 7, wherein the frequency of said electrical stimulation is between about 0.5 Hz and 1000 Hz.

9. The method of claim 1, wherein said molecule is a nucleic acid.

10. The method of claim 10, wherein said nucleic acid encodes a protein and said encoded protein is expressed by muscle cells following step c.

11. A method of delivering a molecule to the skeletal muscle of a mammal in vivo, comprising:

(a) injecting a molecule into skeletal muscle of a mammal, whereby a penetration site and a treatment region are created;

(b) positioning electrodes spaced from said penetration site such that current traveling between the electrodes passes through the treatment region; and

(c) electrically stimulating the muscle with a fixed electrical current that results in field strength that varies with tissue resistance, said field strength varying from about 25 V/cm to less than about 250 V/cm.

12. The method of claim 11, wherein said electrical stimulation is delivered in the form of a single pulse.

13. The method of claim 12, wherein said pulse has a duration of between about 50 μ s and 5000 μ s.

14. The method of claim 11, wherein said electrical stimulation is delivered in the form of between about 2 to 30,000 pulses.

15. The method of claim 14, wherein said pulses have a total duration of between about 10 ms to 12,000 ms.

16. The method of claim 15, wherein said pulses are delivered in the form of at least two trains.

17. The method of claim 16, wherein the frequency of said electrical stimulation is between about 0.5 Hz and 1000 Hz.

18. The method of claim 11, wherein said molecule is a nucleic acid.

19. The method of claim 18, wherein said nucleic acid encodes a protein and said encoded protein is expressed by muscle cells following step c.

20. A method of expressing a polypeptide in a mammal, comprising:

(a) injecting one or more expression vectors into skeletal muscle of a mammal, whereby a penetration site and a treatment region are created, wherein (i) said vector contains a nucleic acid segment that encodes a polypeptide and (ii) said segment is under genetic control suitable to express said polypeptide in cells of said mammal;

(b) positioning electrodes spaced from said penetration site such that current traveling between the electrodes passes through the treatment region; and;

(c) electrically stimulating the muscle with an electrical current.

21. The method of claim 20, wherein said current generates a field strength in the range of from about 25 V/cm to less than 250 V/cm.

22. The method of claim 20, wherein said electrical stimulation is delivered in the form of a single pulse.

23. The method of claim 22, wherein said pulse has a duration of between about 50 μ s and 5000 μ s.

24. The method of claim 20, wherein said electrical stimulation is delivered in the form of between about 2 to 30,000 pulses.

25. The method of claim 24, wherein said pulses have a total duration of between about 10 ms to 12,000 ms.

26. The method of claim 25, wherein said pulses are delivered in the form of at least two trains.

27. The method of claim 26, wherein the frequency of said electrical stimulation is between about 0.5 Hz and 1000 Hz.

28. A method of expressing a polypeptide in a mammal, comprising:

(a) injecting one or more expression vectors into skeletal muscle of a mammal, whereby a penetration site and a treatment region are created, wherein (i) said vector contains a nucleic acid segment that encodes a polypeptide and (ii) said segment is under genetic control suitable to express said polypeptide in cells of said mammal;

(b) positioning electrodes spaced from said penetration site such that current traveling between the electrodes passes through the treatment region; and

(c) electrically stimulating the muscle with an a fixed electrical current that results in field strength that varies with tissue resistance, said field strength varying from about 25 V/cm to less than about 250 V/cm.

29. The method of claim 28, wherein said electrical stimulation is delivered in the form of a single pulse.

30. The method of claim 29, wherein said pulse has a duration of between about 50 μ s and 5000 μ s.

31. The method of claim 28 wherein said electrical stimulation is delivered in the form of between about 2 to 30,000 pulses.

32. The method of claim 31 wherein said pulses have a total duration of between about 10 ms to 12,000 ms.

33. The method of claim 32, wherein said pulses are delivered in the form of at least two trains.

34. The method of claim 33, wherein the frequency of said electrical stimulation is between about 0.5 Hz and 1000 Hz.